

RECENT TENDENCIES IN THE PEDAGOGY OF BIOLOGY

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It appears fair to say that more attention than before is being given to the problem of the teaching of biology. It appears fair to say that problems connected with the uses of biological materials in education are receiving better recognition than heretofore as research problems of real value to science as well as to education. Laboratory methods are being carried over into the investigation of educational problems; and the biologist, for example, who confesses that his research-interest lies in the study of the uses of plants and animals as means in education rather than as ends in themselves needs no longer fear that he will lose caste. Constructive research upon the educational uses of biological materials is finding equal recognition with research in other biological fields. Theses based upon such work may even find equal consideration for the doctor's degree with theses based upon what we somewhat vaguely differentiate as "pure science."

There is a question of distinction here, however. Professor Ganong in his recent revision of *The Teaching Botanist* (p. 58) puts it as follows:

"The temper and temperament required for investigation and for general teaching are not simply different, but are even somewhat antagonistic. * * * * * This applies to the university type of abstract research, the kind which is on the forefront of advancing knowledge; on the other hand it does not apply to some other types of investigation, which are closely and logically connected with the teaching. Of this kind is investigation into the pressing educational problems of the science, a field as difficult and serviceable as anything which the abstract phases of the science have to offer the teacher."

All of which appears to indicate that the day of a science of education approaches. The teachers themselves are looking more to results attained by science-methods, and listening less to the persuasive voice of authority unsupported by evidence which will endure the criteria of science. The need for thoroughly trained investigators in education is enlarging; not so much because the results of their work will be more accurate now than formerly, as

because they may obtain now a larger hearing than formerly. The results of their researches will have real effects upon procedure. Whereas, even a decade ago, they would have had slight notice, so dominant in the educational world was mere opinion; so ascendant was authority based on little more than the prestige which position and vigorous assertion give. Such dominance and such ascendancy are passing. (An excellent presentation of this point is found in Bagley's "The Scientific Method in Educational Research," *Nature Study Review*, Sept. 1910.)

The natural divisions of the uses of biological materials in education are:—those of the elementary school, of the secondary school, and of the college or university. Of the problems lying in the first of these divisions, Professor Ganong writes that they are "as much psychological as scientific." (*The Teaching Botanist*, p. 3.) We may leave it to the psychologist to resent any invidiousness in this distinction, and merely accept the thought behind as reason for the omission of "nature-study" problems from this review, so far, at least, as the elementary school is concerned. The omission of college and university problems is warranted, partly because they are less than those of the high school, partly because opinion about them is less accessible, partly by the page limits of the review, and mainly because the reviewer finds himself even less ready to discuss them. It seems safe to say, however, that post-high-school biology teaching is in far more satisfactory condition than that done in the high school.

Only in a negligible minority of high schools do "botany" or "zoology" appear as required subjects later than the second year. Hence the problem in this field narrows itself to youths of from 14 to 16 years, and the "psychological" element is obvious. To the writer a present basic question appears to be whether children of this age are, or are not, ready to profit by the study of science; is it desirable or is it foolish to attempt at this age the inculcation of the scientific spirit? Upon the answer to this psychological query appears to rest the whole matter of method in the use of biological materials in the high schools, at least in the years in which they are now almost exclusively used. Let it be clear, however, that this answer will furnish a basis for method alone. It would furnish no basis at all for the exclusion of plant and animal materials from the program, though it might furnish ample warrant

for discontinuing to name such uses either "botany," or "zoology," or even "general biology." For the thing sought all of these may prove misnomers, if they are not already misnomers for things urged and attempted in their name.

We find at present urged at least three types of high school courses in these materials. These may be roughly differentiated as "economic," "natural history," and "pure science." The limits of this review make it almost imperative to assume that these terms are self explanatory.

Inquiries which the writer has made in the Middle West are supported by numerous published opinions in warranting the assertion that college and university men—the professional biologists—while showing considerable variation of opinion in minor matters, hold practically together in the opinion that "pure science" should dominate in the use of biological materials in the secondary schools. The school masters, on the other hand, hold with equal unanimity, for "economic" or "natural history" dominance. The position of the scientists is succinctly put in the following sentence: "To begin with economics and to work back to the scientific basis thereof seems to me justified neither by theory nor experience; while beginning with scientific study and working thence to economics seems to me in accord with both." (Ganong, *The Teaching Botanist*, p. 46.)

A similarly definite statement of the position of the school men is not at hand, but it appears to the writer to be somewhat as follows: Educational values are evident only as conduct is affected. We are thoroughly sceptical of the conduct-effects of pure science teaching in the first and second years of the high schools, at least so far as its effects may be judged from the kind of teaching we are now able to find and employ. Its values do not appeal to adolescents of that period. The "human interests" should dominate in the use of biological materials in these years, whereby we may directly affect conduct through precept and example, dealing with familiar and economically important plants and animals. Content deserves consideration over method at this stage. We grant the theoretical values of pure science methods, but we have not had adequate evidence of their benefits in this place in education. We know that we can teach a boy to make a better garden and that he will largely do the things we teach him how to do. They appeal to

him. We do not know that we can make him a better thinker, or a better citizen, through pure science at this stage, and we prefer the certain, tangible values to these uncertain mental ones we have scant proof for. We can teach him how to do at this stage much better than we can teach him how to think.

It appears to be true that this divergence of opinion is more apparent than real, at least to the extent that what many school men are seeking as "botany" and "zoology" are not such in any strict manner of speaking. If they find fault that the teachers they obtain from universities, as teachers of botany or zoology, are not trained in agriculture, horticulture, or forestry, bits of which they ask to be included as botany, they should not find that fault with the university which makes no claim to include these divisions in its science departments, but rather with conditions which provide as yet no adequate facilities for the training of such teachers as they desire.

Dewey (Science as Subject Matter and as Method; *Science*, Jan. 28, 1910) makes a case against the educational value in science as it has been taught, but remains true to the university ideal as to how it should be taught. He does not pretend, however, to limit himself to the under years of the high school as to pupils, nor to the actual limitations as to teachers. His conclusions, however, point to radical alteration as to content even of the pure science course. To achieve the training in method he advocates, limitations of time would require extensive elimination of matter at present required by universities for entrance.

The infinitely extensive character of natural facts and the universal character of the laws formulated about them is sometimes claimed to give science an advantage over literature. But viewed from the standpoint of education, this presumed superiority turns out a defect; that is to say, so long as we confine ourselves to the point of view of subject-matter. Just because the facts of nature are multitudinous, inexhaustible, they begin nowhere and end nowhere in particular, and hence are not, just as facts, the best material for the education of those whose lives are centered in quite local situations and whose careers are irretrievably partial and specific. If we turn from multiplicity of detail to general laws, we find indeed that the laws of science are universal, but we also find that for educational purposes their universality means abstractness and remoteness. The conditions, the interests, the ends of conduct are irredeemably concrete and specific. We do not live in a medium of universal principles, but by means of adaptations, through concessions and compromises, struggling as best we may to enlarge

the range of a concrete here-and-now. So far as acquaintance is concerned, it is the individualized and the humanly limited that helps, not the bare universal and the inexhaustibly multifarious. * * * * *

Something of the current flippancy of belief and quasi-scepticism must also be charged to the state of science teaching. The man of even ordinary culture is aware of the rapid changes of subject-matter, and taught so that he believes subject-matter, not method, constitutes science, he remarks to himself that if this is science, then science is in constant change, and there is no certainty anywhere. If the emphasis had been put upon method of attack and mastery, from this change he would have learned the lesson of curiosity, flexibility and patient search; as it is, the result too often is a blasé satiety.

I do not mean that our schools should be expected to send forth their students equipped as judges of truth and falsity in specialized scientific matters. But that the great majority of those who leave school should have some idea of the kind of evidence required to substantiate given types of belief does not seem unreasonable. Nor is it absurd to expect that they should go forth with a lively interest in the ways in which knowledge is improved, and a marked distaste for all conclusions reached in disharmony with the methods of scientific inquiry. It would be absurd, for example, to expect any large number to master the technical methods of determining distance, direction and position in the arctic regions; it would perhaps be possible to develop a state of mind with American people in general in which the supposedly keen American sense of humor would react, when it is proposed to settle the question of reaching the pole by aldermanic resolutions and straw votes in railway trains or even newspaper editorials. * * *

Mankind so far has been ruled by things and by words, not by thought; for, till the last few moments of history, humanity has not been in possession of the conditions of secure and effective thinking. Without ignoring in the least the consolation that has come to men from their literary education, I would even go so far as to say that only the gradual replacing of a literary by a scientific education can assure to man the progressive amelioration of his lot. Unless we master things, we shall continue to be mastered by them; the magic that words cast upon things may indeed disguise our subjection or render us less dissatisfied with it, but after all science, not words, casts the only compelling spell upon things. * * * * *

The modern warship seems symbolic of the present position of science in life and education. The warship could not exist were it not for science: mathematics, mechanics, chemistry, electricity supply the technique of its construction and management. But the aims, the ideals in whose service this marvelous technique is displayed are survivals of a pre-scientific age, that is, of barbarism. Science has as yet had next to nothing to do with forming the social and moral ideals for the sake of which she is used. Even where science has received its most attentive recognition, it has remained a servant of ends imposed from alien traditions. If ever we are to be governed by intelligence, not by things and by words, science must have something to say about *what* we do, and not merely about *how* we may do it most

easily and economically. And if this consummation is achieved, the transformation must occur through education, by bringing home to men's habitual inclination and attitude the significance of genuine knowledge and the full import of the conditions requisite for its attainment. Actively to participate in the making of knowledge is the highest prerogative of man and the only warrant of his freedom. When our schools truly become laboratories of knowledge-making, not mills fitted out with information-hoppers, there will no longer be need to discuss the place of science in education.

Ganong (Some Reflections upon Botanical Education in America, *Science*, March 7, 1910) makes a similar point which, to accomplish, would also require vigorous pruning of the course under present high school conditions.

Another phase of our treason to the genius of science is found in the belief and practise of some teachers that broad generalizations are the true aim of elementary teaching. I know a recent elementary textbook in which the author laments that "some teachers do not yet understand the importance of imparting to beginners a general rather than a special view point." And I could cite many passages to show a belief of this and some other teachers that subject matter, accuracy in details, and other fundamental verities of science, are not important in comparison with "view-points" and "outlooks on life" and that sort of thing. In my opinion there can be no greater educational error. There is no training which American youth needs more than that in a power to acquire knowledge accurately and to work details well. Disregard for particulars and a tendency to easy generalities are fundamental faults in American character, and need no cultivation, but, instead, a rigorous correction.

In whichever direction we look radical change appears to be more or less imminent. It is frequently suggested that such change may lead to distinct differentiation between city and country conditions, the thought being that city schools must, from the very conditions of their environment, hold to "pure science" ideals, while the country, with wealth of materials at hand, may more reasonably make environment the basis, at least for materials.

Another argument for the "natural history" method is based upon the fact that chemistry and physics are firmly entrenched in the upper high school years, and that much of the experimental work in biology, urged by "pure science" and "scientific habit of thought" advocates, is pointless without a knowledge of these. But the strongest and the simplest argument brought forward by the school men is, perhaps, that teachers qualified to train boys and girls in the scientific spirit, admittedly a teaching calling for high

qualifications, are not usually obtainable with the present status of salaries. Society, if it wants better thinkers turned out by its schools, must pay a higher school tax. Effort has been made, notably in New York State, to solve the pedagogical problem by a first year course in General Biology; while important schools, as the high school at Springfield, Mass., and the University High School in Chicago, have early courses in General Science. In the former case the attempt appears to involve no important reduction in the amount of material used, but rather to increase correlation and synthesis, with a large emphasis on "human interest." In the latter cases there is frank concession to the "natural history" idea, the course being required of all students. Later electives in botany and zoology are also offered. To such a plan there are serious physical obstacles so far as the average high school is concerned.

The following references may be added to those already given, as having special value in indicating modern tendencies in respect to the teaching of Biology:

- CALDWELL, O. W.—"The Principles that Should Determine the Courses in Biology in Secondary Schools." *School Sci. and Math.*, Mch. 1909.
- GALLOWAY, T. W.—"An Appreciation of the Pedagogical Possibilities of the Biological Laboratory." *School Sci. and Math.*, Feb. 1908.
- GALLOWAY, T. W.—"Elementary Zoology." 1910, P. Blakiston's Son & Co., Philadelphia. In the writer's opinion this book represents the most distinct advance which has been made in the way of a text book toward the ideals of Dewey and toward some of those of Ganong.
- GRUENBERG, BENJ. C.—"Some By-Products of Biology Teaching." *School Sci. and Math.*, Apr. 1908.